Document # UM130816 Rev1

AXIS-TRS Utrafast Time-Resolved Spectrometer

User Manual

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Information in this publication supersedes that in all previously published material.

Table of content

1 Scope of Document and History

This document is the user manual for the AXIS-TRS. It describes the instrument from the point of view of the user. It does not contain information which is specific to an instrument (calibration data, configuration, etc.)

This document is meant to be used in conjunction with the instrument's Tests report.

History

Revision	Date	Changes
1	August 16th, 2013	Initial release

2 Introduction

The AXIS-TRS Time-Resolved Spectrometer is a fully integrated and autonomous instrument which is remote-controlled using a web interface.

The camera system is composed of the following parts:

- The AXIS-TRS Main unit
- a Laser-Triggered Sweep Unit
- a MHz nanosecond sweep unit

3

General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

This equipment contains high voltage power supplies and careless use could result in electric shock. It is assumed that this highly specialized equipment will only be used by qualified personnel.

The manufacturers and suppliers accept no responsibility for any electric shock or injury arising from use or misuse of this equipment. It is the responsibility of the user to exercise care and common sense with this equipment.

Use proper power supply. Use only a power supply as specified in this document.

Ground the product. This product is grounded through the grounding conductor of the power connector and through a protective earth wingnut. To avoid electric shock, the grounding conductors must be connected to earth ground.

Power disconnect. Switching the computer off DOES NOT disconnect the product from the power source. The only way is to physically disconnect the power cord.

Do not operate without covers. Do not operate this product with covers or panels removed.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Use in laboratory environment. This instrument is designed for use in a laboratory environment with controlled temperature and humidity. Do not operate in wet/damp conditions.

4 Compliance Information

The instrument has been tested to meet the following standards:

EN 61326-1:2006. EMC requirements for electrical equipment for measurement, control, and laboratory use.

EN 61010-1: 2001. Safety requirements for electrical equipment for measurement control and laboratory use.

EN 60825-1: 2007. Safety of laser products

Directives 2002/96/EC and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries.

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive.

5 System configuration

5.1 Physical description

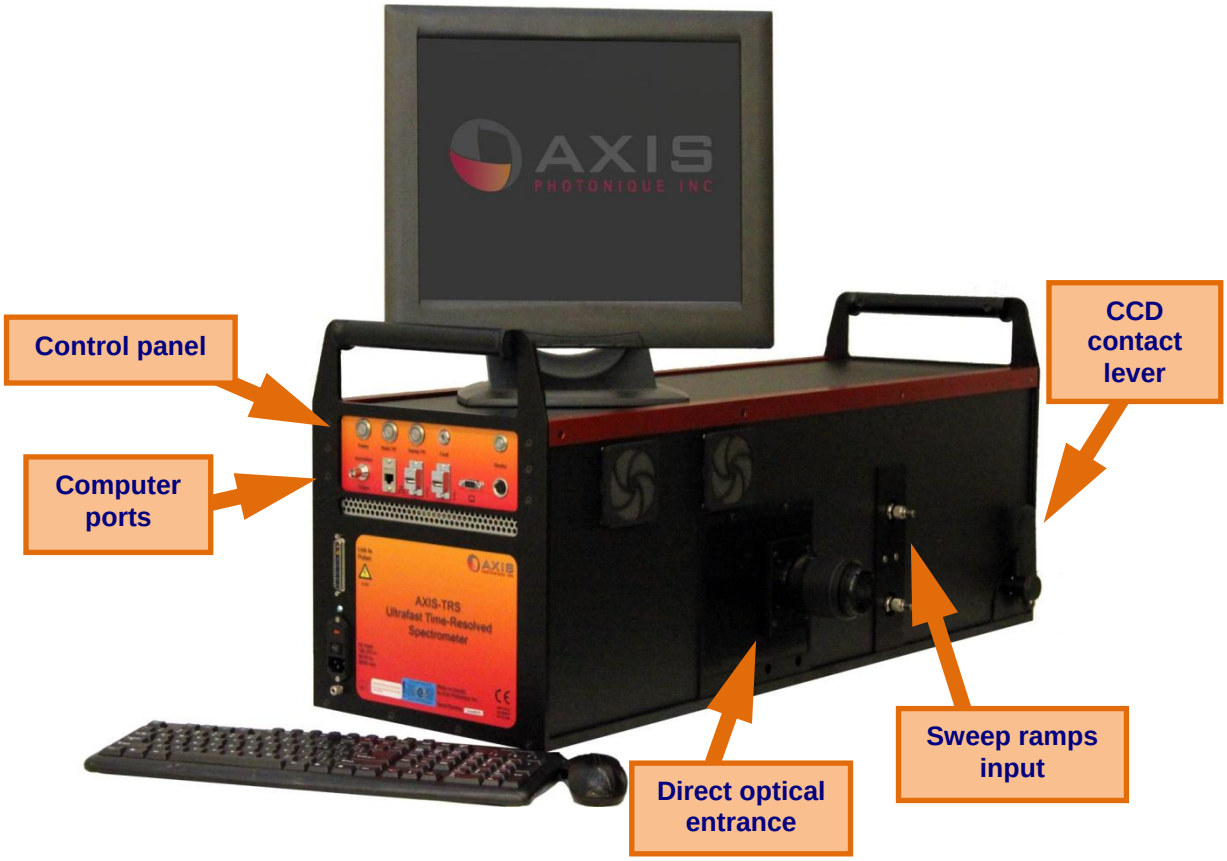


Figure 1 : Picture of complete system

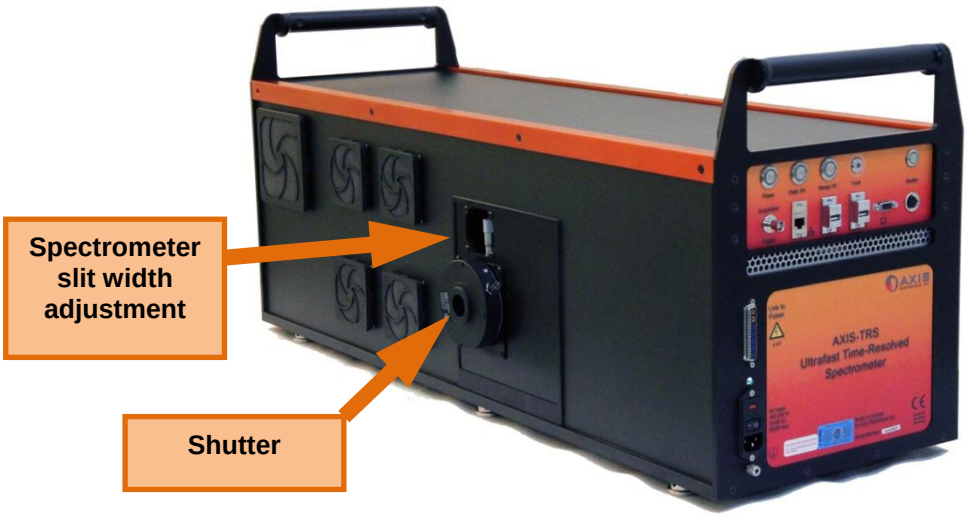


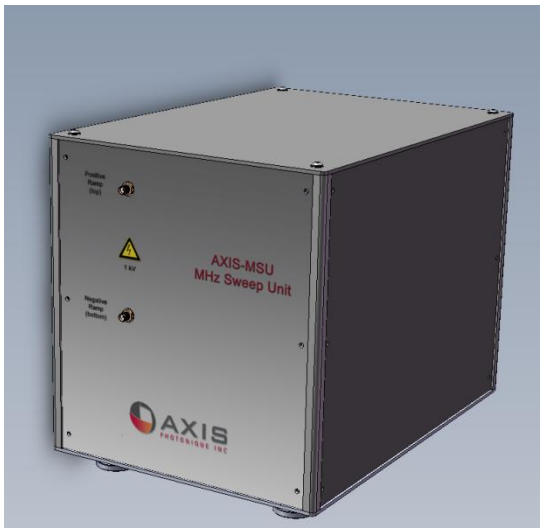
Figure 2 : Picture of complete system (left side)

5.2 Accessories

5.2.1 Sweep Units

The instrument has been build and tested with 2 different sweep units: the MHz Sweep Unit and the Laser-Triggered sweep unit (LTSU).

The MHz Sweep Unit uses an electrical trigger to generate the ramps. It is designed to work with an oscillator coupled with a pulse picker that brings the laser repetition rate to 1 MHz. It has a jitter of about 20ps which is the factor the defines time resolution of the system. Therefore, it is used to observe physical phenomena on a time range of 10 ns to 100 ns.



The LTSU uses a laser pulse to generate the sweep ramps for the streak tube. It is designed to be used with a kHz laser. I allows a time resolution of 1-2 ps in averaging mode with 750 ps range.

6 Inputs and Outputs of the instrument

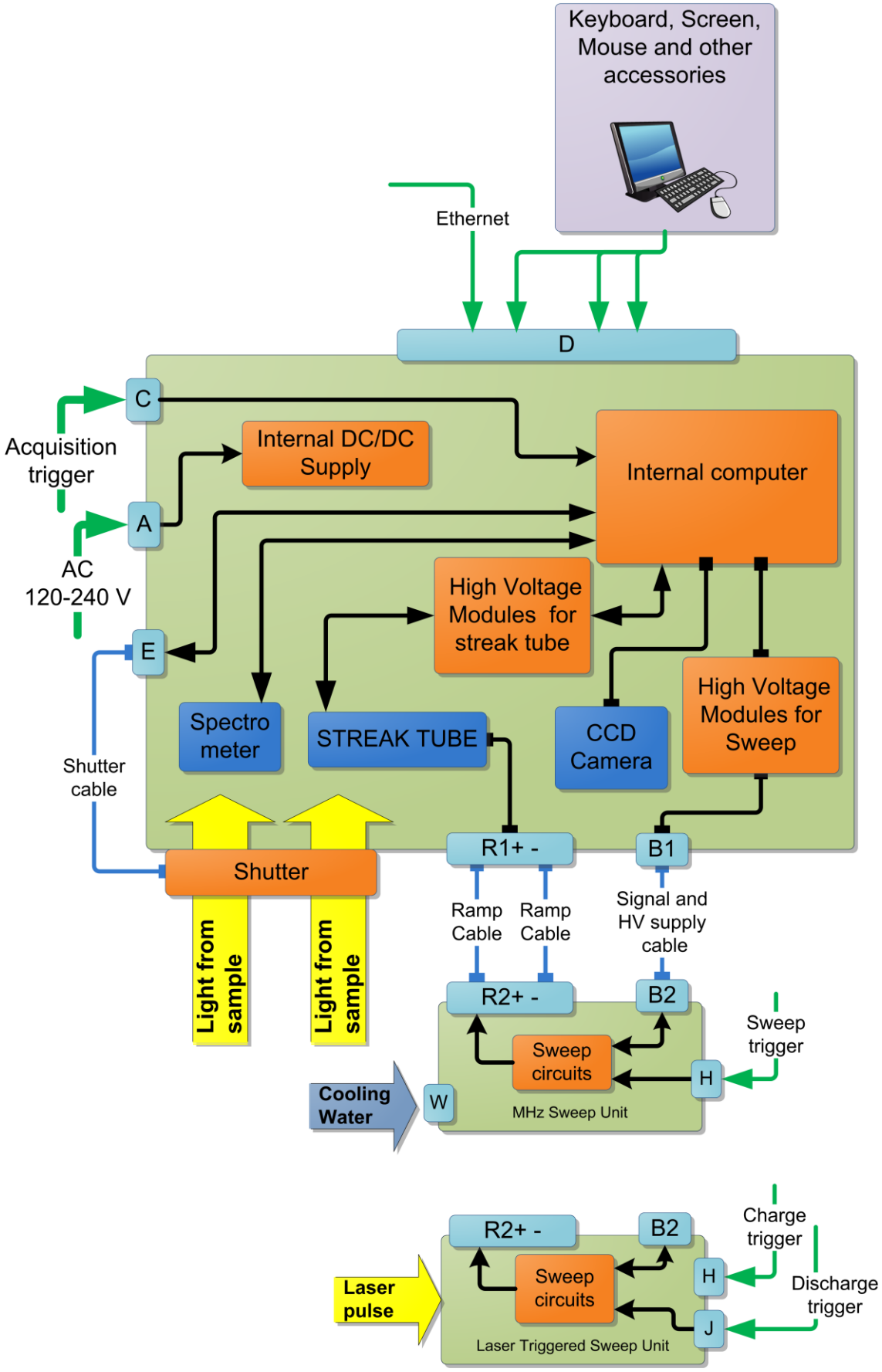


Figure 3 : Simplified Schematics of the hardware

6.1 Connexions

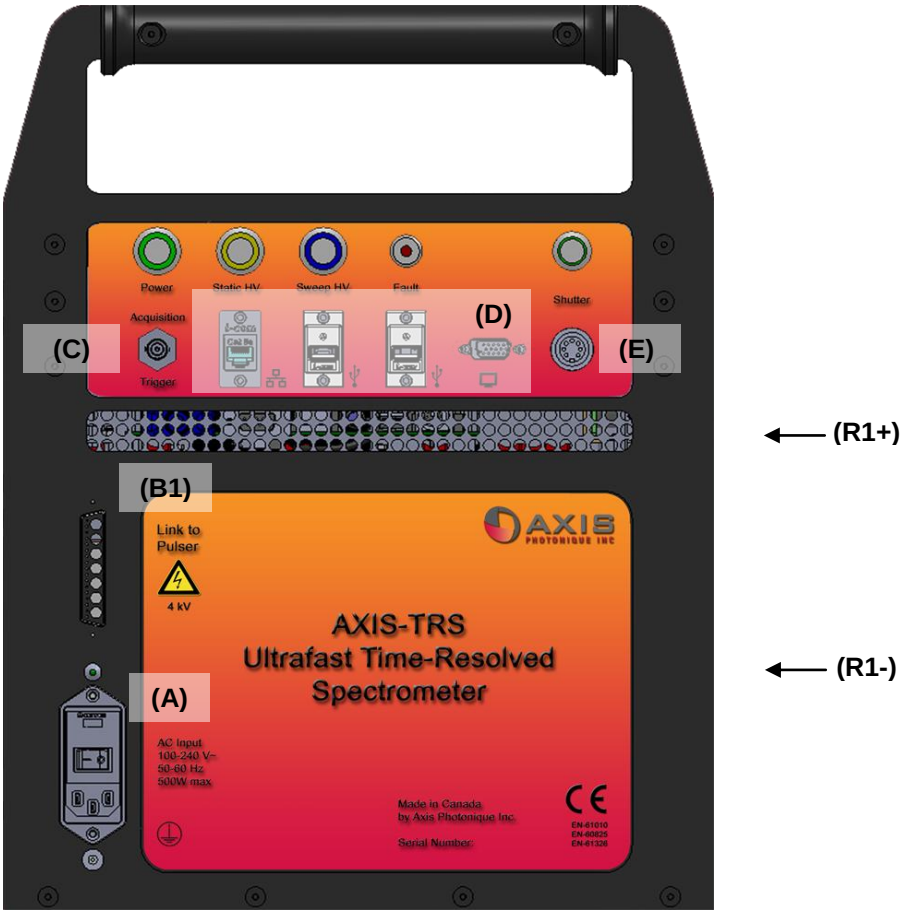


Figure 4 : Back panel of the Main Unit

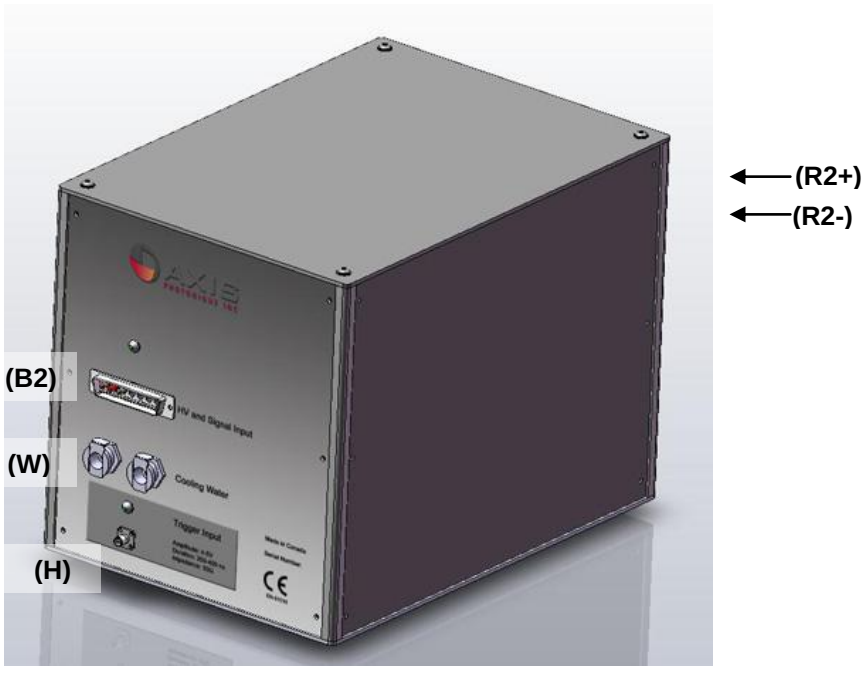


Figure 5 : Panel of the Nanosecond Sweep Unit

Figure 6 : Panels of the Laser-Triggered Sweep Unit

6.1.1 Main power (A)

The system is meant to be powered on AC (120-240 V, 50-60 Hz). Inside the camera, the isolated supply modules (ISM) generates all voltages required for the system.

6.1.2 Signal and HV Cable for Sweep Unit (B)

This cable brings power to the camera head from the Control Unit.

For safety reasons HV supplies cannot be turned ON if this cable is not properly connected to the receptacles.

6.1.3 Triggers (C, H and J)

The instrument requires two triggers; the **acquisition trigger** that starts the exposition of the CCD and the **sweep trigger** that starts the sweep ramps.

The **acquisition trigger** can tolerate about 1ns of jitter and it is used to trigger the CCD acquisition. The CCD exposure time is set by the software. The acquisition trigger circuit accepts amplitudes of 5-30V in 50Ω, with a duration of >20 µs. This trigger input (C) is a BNC connector located on the main unit.

The **sweep trigger for the nanosecond sweep unit** is connected via high quality, high frequency coaxial cable and SMA connectors directly to the sweep generators through a minimum of circuitry in order to preserve signal integrity and minimize jitter. The sweep trigger circuit accepts amplitudes of 5-10V in 50Ω, with a duration of 15-100ns. Jitter on this signal will dictate the overall time resolution of the system in accumulation mode. SMA connectors. This trigger input (H) is an SMA connector located on the sweep unit.

The **Laser-Triggered sweep unit** requires 2 trigger signals. the first one to charge the photo-switch (H) and the second one to discharge it (J). They both use BNC connectors. The trigger circuits accepts amplitudes of 5-10V in 50Ω, with a duration of 100-200ns. Jitter on this signal should be better than 1 ns.

6.1.4 Internal Computer Access (D)

Access to the internal computer is done through standard ports:

- Ethernet port.
- 2 USB port
- VGA monitor to the monitor port.

To control the camera locally, one needs to connect input devices (mouse and keyboard) and a screen.

6.1.5 Electromechanical Shutter (E)

This 6-foot cable powers up the electromechanical shutter.

6.1.6 Ramps to the streak tube (R)

There are 2 cables that have to be connected between the sweep unit and the main unit. They bring the HV ramps to the streak tube. On the side of the main unit, the connectors are TNC type.

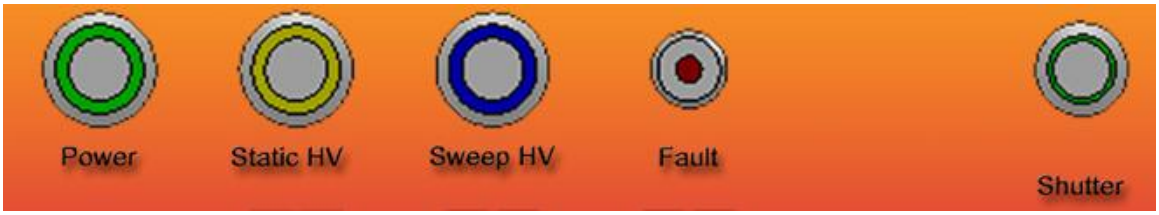
6.1.7 Cooling Water connectors (W)

Cooling water is required to stabilize the sweep ramps of the MHz sweep unit. There are two water connectors, an inlet and an outlet.

The connectors are quick-connect fitting (CPC Colder PLCD10004) with a spring valve.

It is meant to mate with a quick-connect fitting (CPC Colder PLCD22006)

7 Hardware User Interface



Main Power button:

The "Main Power" button is the push-button surrounded by a GREEN LED. The green LED represents the state of the internal electronics.

When the user pushes on the button the green LED start blinking. All electronics are powered and the computer boots up. When the computer has successfully performed the initialization procedure (30-60 seconds) and is ready to receive commands, the green LED stops blinking and stays on.

When the user pushes the button, green LED start blinking and the computer starts shutting down. When the computer has successfully performed the shut down procedure, the remaining electronics are turned off and the green LED stops blinking and turns off.

In the unlikely case of the computer becoming unresponsive, this button can be held for 5 second and the PC supply will be turned off.

Static HV button:

The "Static HV" button is the push-button surrounded by a YELLOW LED. The yellow LED represents the state of the static high voltages (cathode, focussing electrodes and bias voltages).

When the user pushes on the button, the yellow LED start blinking. The HV turn on procedure is started. When all voltages have reach their operation level and are stable, the yellow LED stops blinking and stays on.

When the user pushes on the button, the yellow LED start blinking. The HV turn off procedure is started. When the HV converters are all off, the yellow LED stops blinking and turns off.

The yellow LED blinks when the camera is changing mode.

The "HV" button is also used to reset an error (see further).

Sweep HV button:

The "Sweep HV" button is a push-button surrounded by a BLUE LED. The blue LED represents the state of sweep unit and the sweep trigger.

When the user pushes the button, the blue LED blinks for a while and stays on, the sweep unit is activated and the sweep trigger is enabled. For some sweep units, the blue LED will flash fast when the sweep unit is functional but required warming up.

When the user pushes on the button again, the trigger is disabled and the sweep unit is de-activated.

In static mode, the button is disabled

"FAULT" LED

The "FAULT" LED represents the error state of system.

If, at any time, the current drawn from any HV converter becomes high than a safe limit, all voltages are turned off and the red FAULT LED starts blinking fast. (Example: an HV electrode has suddenly discharged)

If, at any time, an interlock from the case, the HV cable or the vacuum is open, all voltages are turned off and the red FAULT LED starts blinking slowly.

If, at any time, any other system error occurs, all voltages are turned off and the red FAULT LED turns on.

It will turn off only when the error has been reset (by pushing once on "Static HV" or by sending the reset command from the software interface.

"Shutter"

The "Shutter" button is a push-button surrounded by a GREEN LED. The LED is green when the shutter is open, it will briefly turn on when the software opens the shutter. Pushing the center button locks the shutter open.

8 Software Interface

The streak camera system is driven by 3 independent applications.

- The ACTON Monochromator Control Software
- the AXIS web application which controls the voltages applied on the streak tube and the sweep unit.
- The SI Image SGL software written by Spectral Instruments, the supplier of the CCD camera.

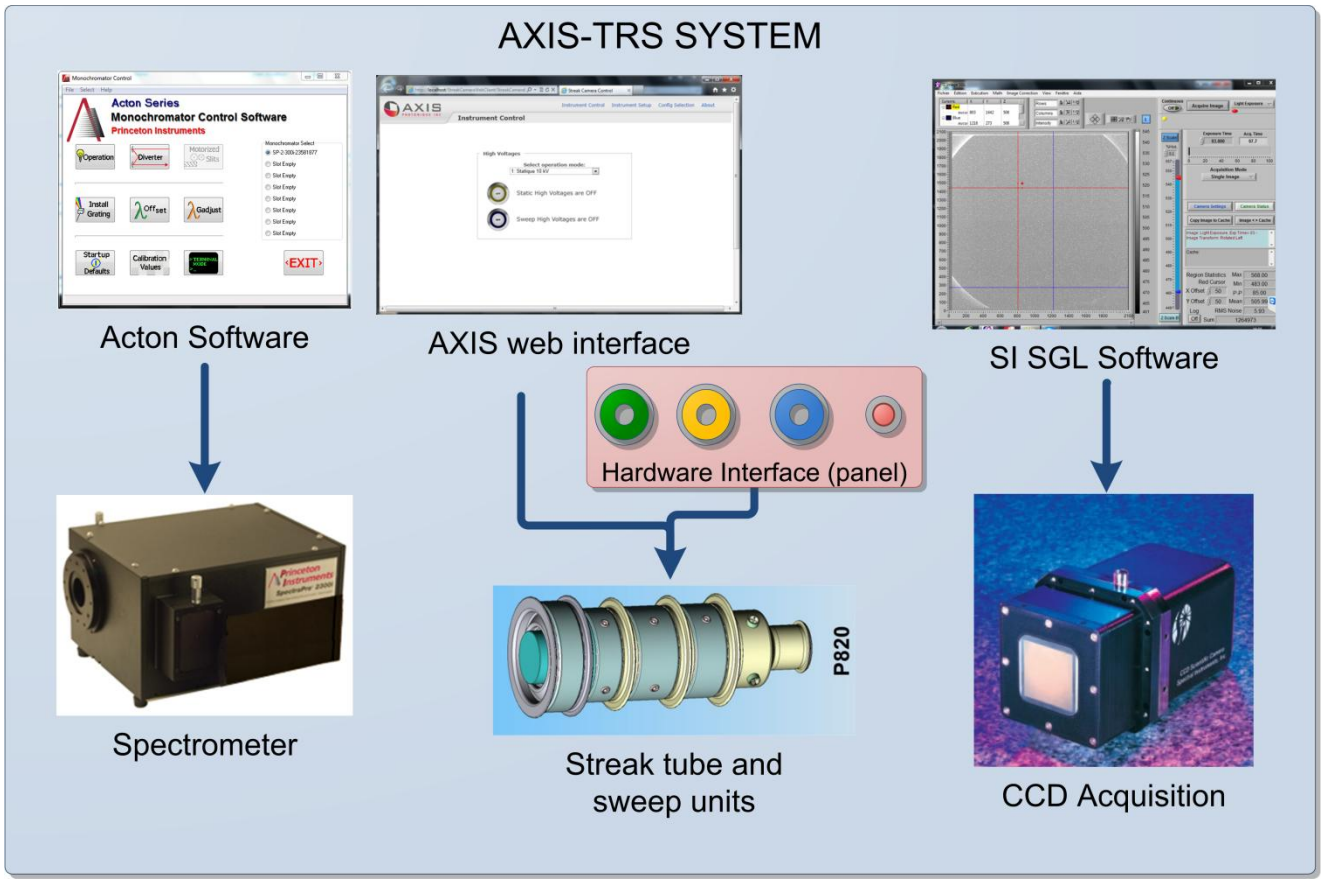
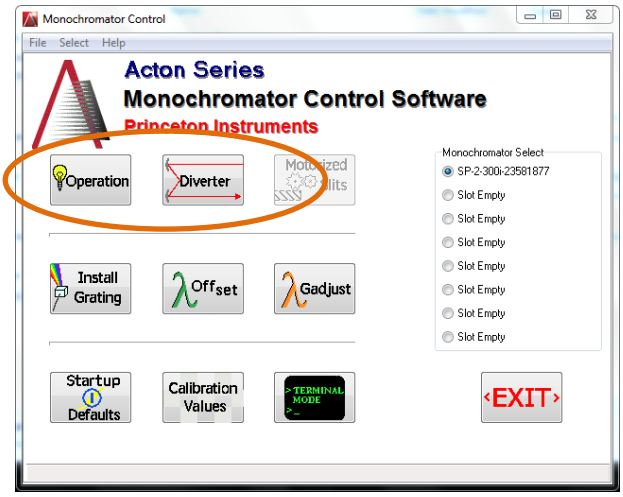


Figure 7 : Simplified schematics of the software

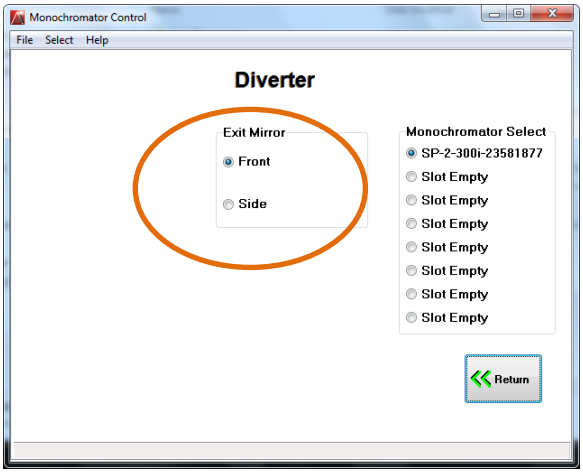
8.1 Acton MonoControl Software

This software controls the spectrometer.



The features that are of interest for the AXIS-TRS are the "DIVERTER" and the "OPERATION" buttons.

8.1.1 Diverter



The diverter is a mirror which selects the input port of the spectrometer:

FRONT: Streak tube looks at light coming from spectrometer
SIDE: Spectrometer is bypassed and streak tube looks at light coming from the direct entrance

Note: this mirror has been modified form the original setting; it was originally made to switch the output of the spectrometer. Please disregard the terms used in the software interface.

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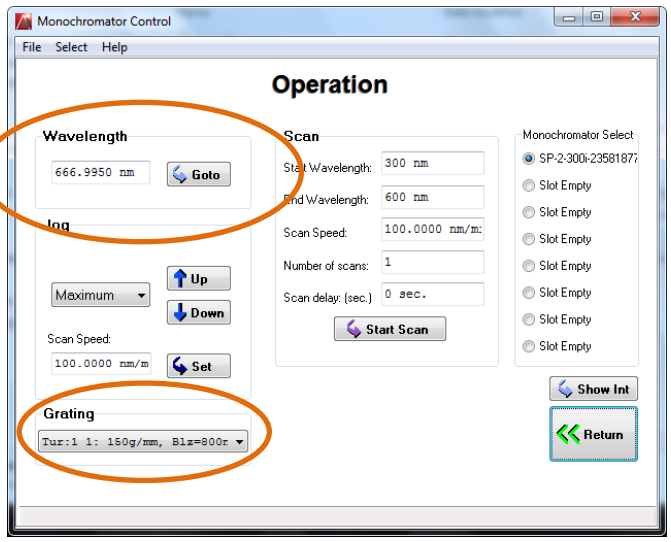
8.1.2 Operation



This window allows to choose the center wavelength of the spectrometer and also choose the grating when more than one are installed.

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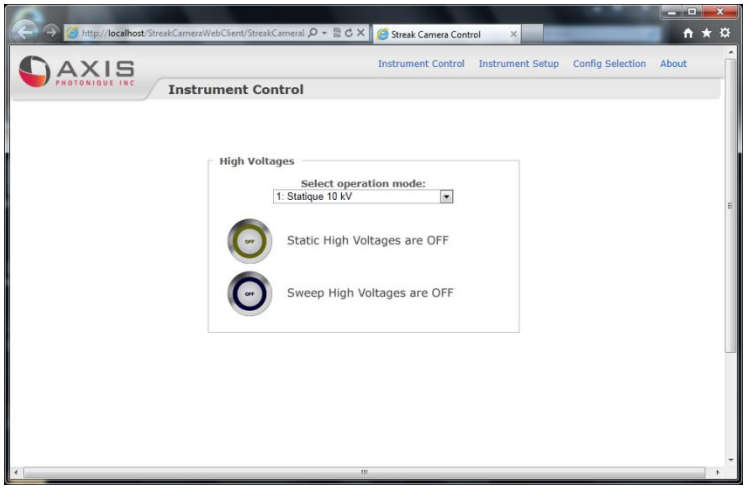
8.2 Web Interface

The web interface is used for the initial setup and to drive the streak camera.



The "Instrument Control" page is used to:

- Select the operation mode: ex: Static, Timing, Sweep.
- Turn the Static voltages and Sweep voltages on or off

To connect to the web interface, the recommended browser is Microsoft Internet Explorer 8 but in principle any browser should work.

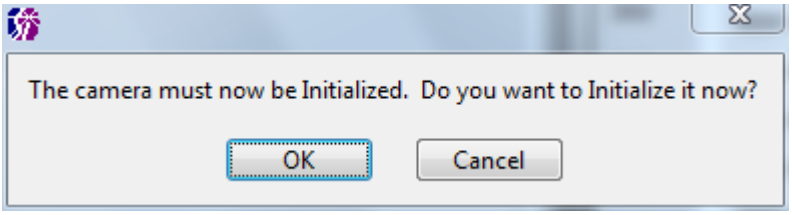
The browser can run on the host computer but also on any machine that can reach the host computer on the network.

The URL is HTTP http://**IP**/StreakCameraWebClient
where **IP** is the IP address of the streak camera on the local network
or "localhost" if the web browser runs on the camera's computer itself.

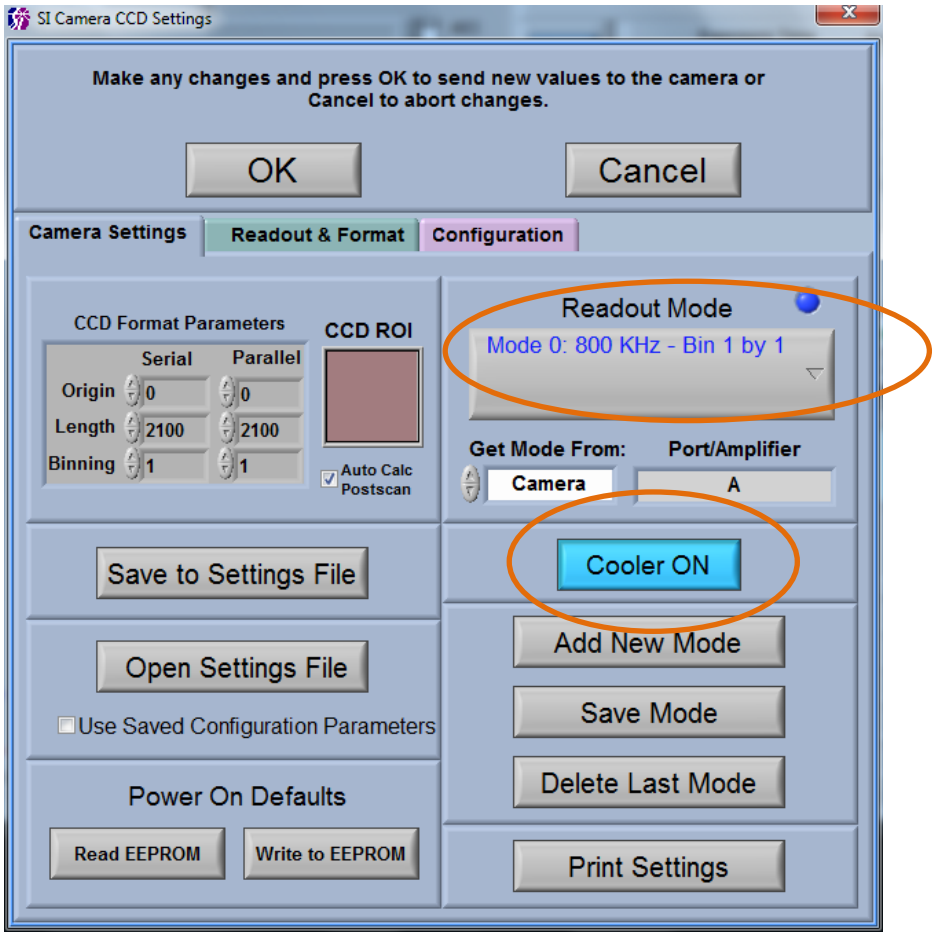
8.3 Spectral Instruments Image SGL software

This software is supplied with the CCD camera. It is used to control the CCD camera, acquire the images, analyze them and save them on the hard drive of the Control Unit.

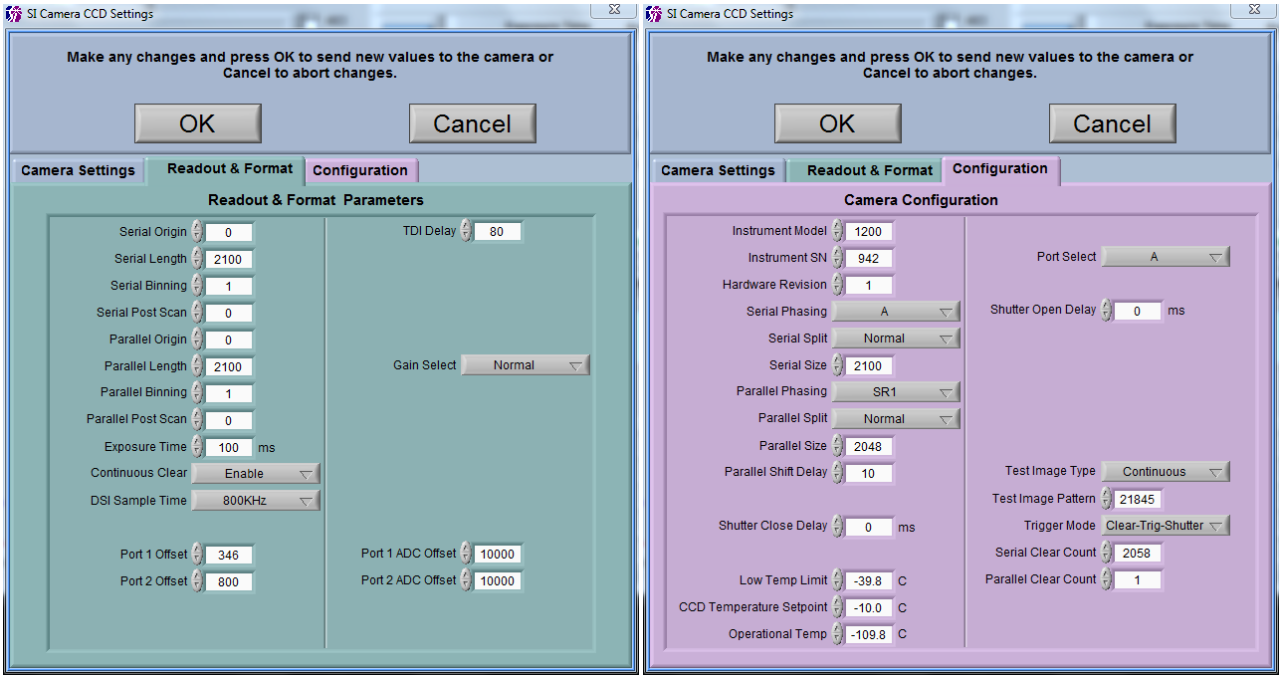
When this software is started is asks to initialize the CCD camera.



Then, one select the Readout mode (Usually Mode0 : 800 kHz) and turn the Peltier cooler on.

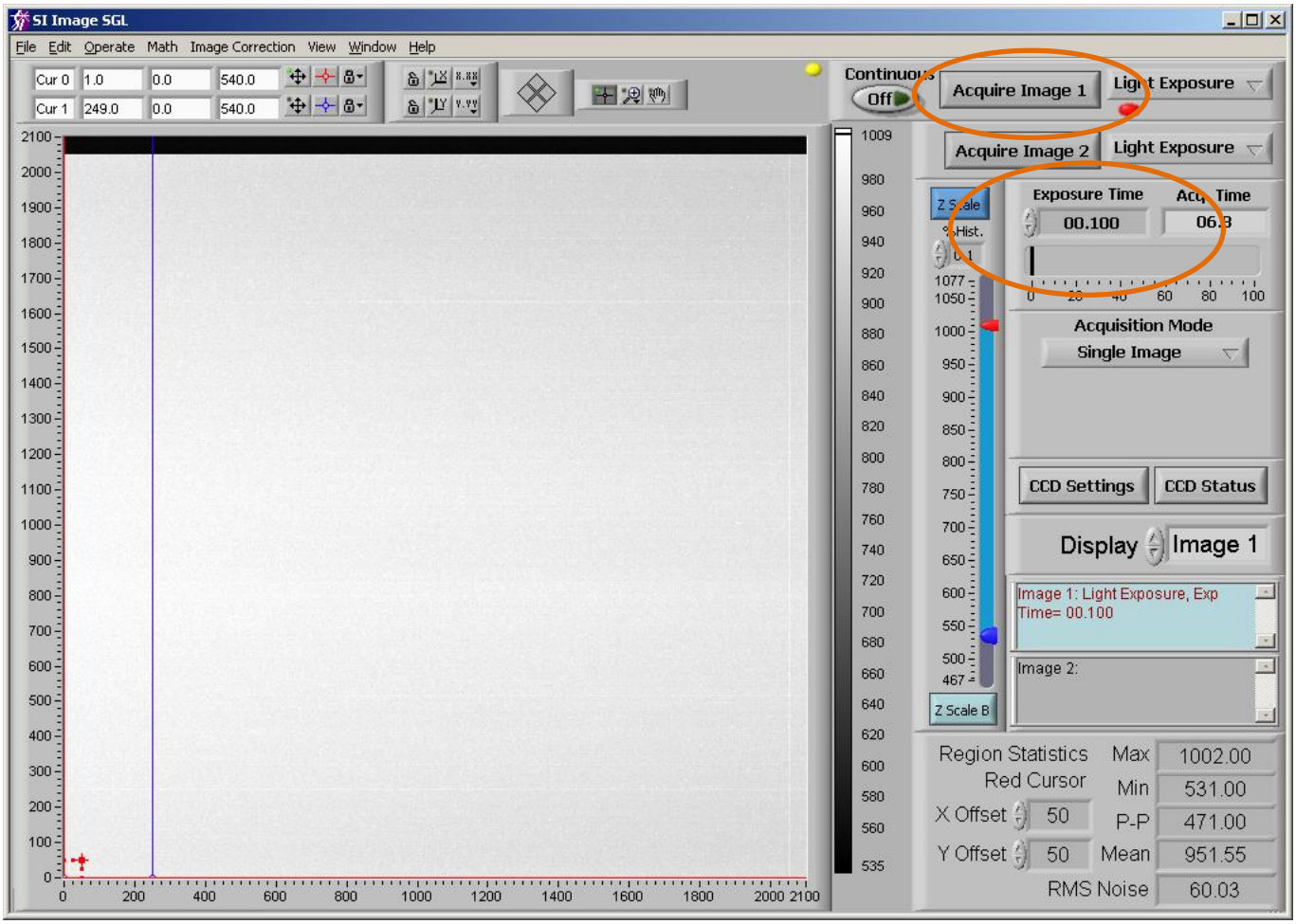


The other tabs (Readout & Format and Configuration) should remain unchanged.



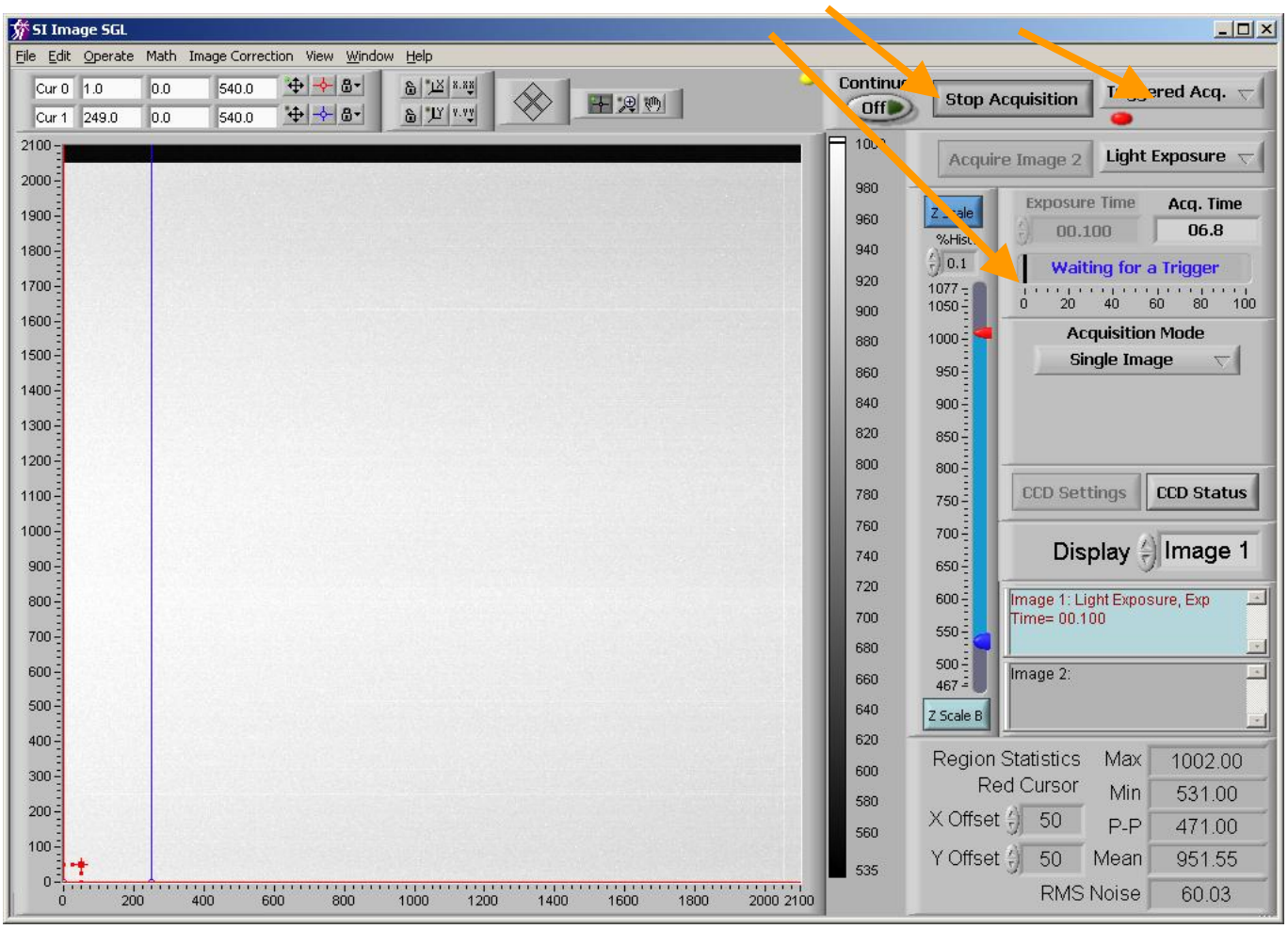
Click OK. The main screen appears.

On can acquire an image by setting the exposure time and clicking on "Acquire Image 1".



In the case the image has to be externally triggered, one would send a trigger to the ACQ trigger connector located beside the computer ports.

To prepare for a streak camera shot, one should set the pull-down menu to "Triggered Acq." and click "acquire image". The software displays "Waiting for a trigger".

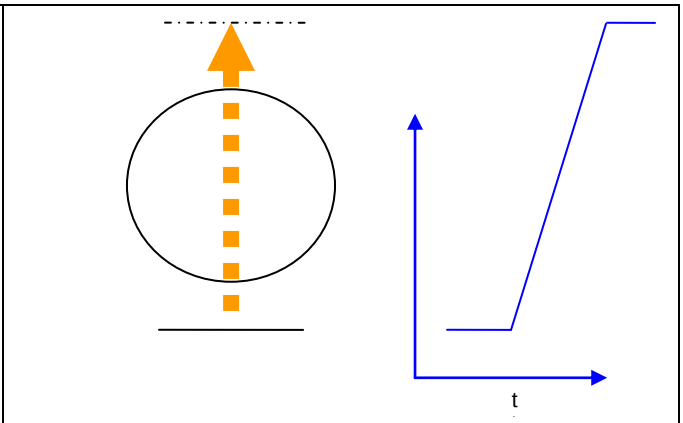
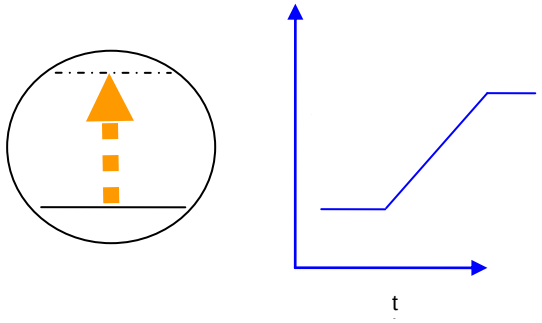
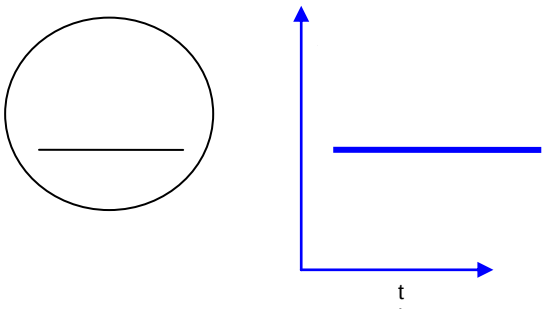


For more details about operation of this software please consult the Spectral Instruments manual.

9 Operation Basics

9.1 Operation modes

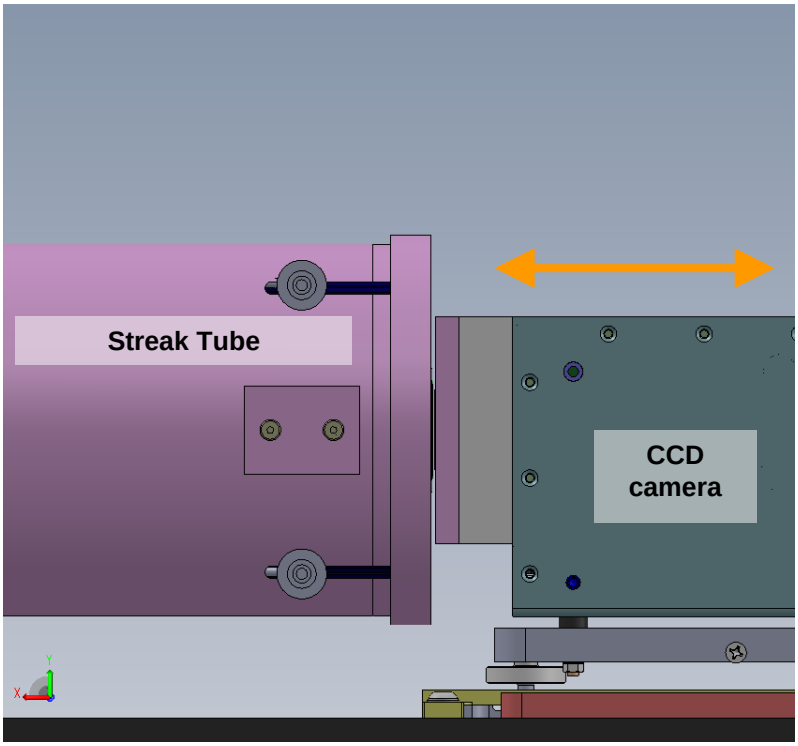
The available sweep modes are Normal Sweep, Timing, Focus and Slow Scan and are described below.

NORMAL SWEEP MODE	A bias voltage is applied such that the sweep starts out of the screen. The sweep accelerates to a constant speed, crosses the whole screen and ends outside the screen. **For this camera**, the available sweep ranges are: 10ns, 100ns and 500ns.	
TIMING MODE	A bias voltage is applied such that the sweep starts in the screen. The signal sweeps at the selected speed but the amplitude of the ramps are reduced such that a streaked image is always seen on the screen.	
STATIC MODE	A bias voltage is applied to position the static trace anywhere on the screen. The sweep trigger is disabled.	

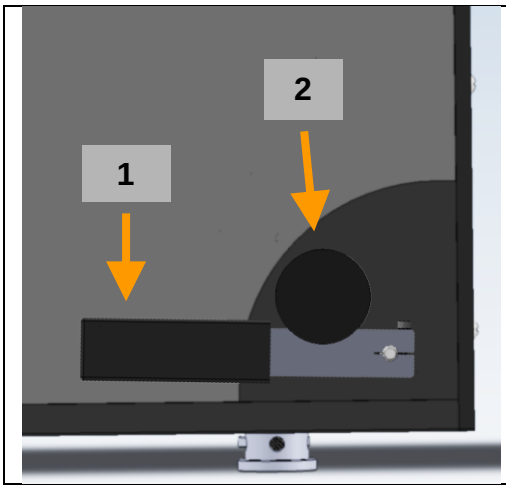
10 Installing and testing the system

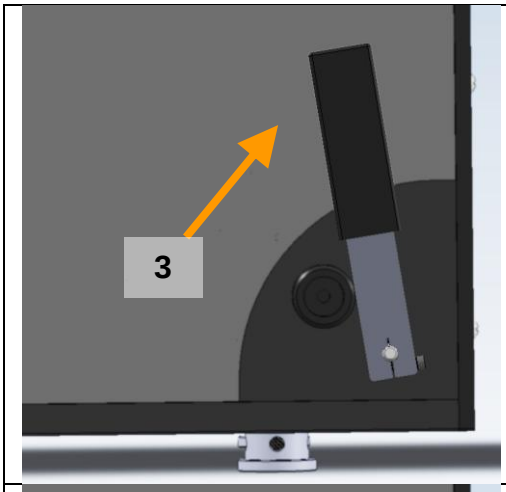
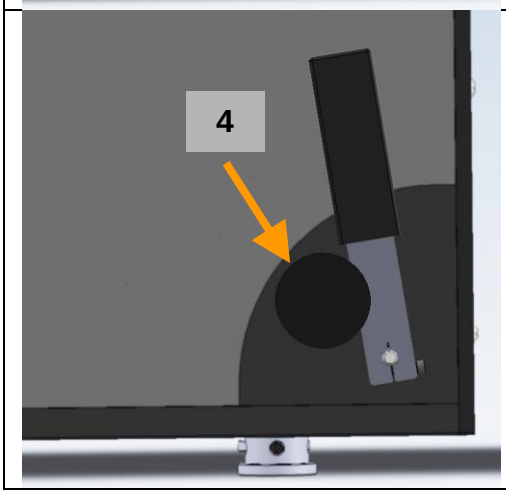
10.1 Coupling the CCD to the streak tube

To avoid damaging the fiber taper (on the CCD and on the streak tube), the CCD is decoupled for shipping.



Upon reception, the CCD camera must properly couple to the streak tube.

	Initial Position: CCD decoupled. The CCD fiber taper is a few mm away from the streak tube screen. To couple the CCD: 1- apply pressure downward on lever 2- unscrew the knob and take it out

	3- Gently lift the lever so it clears the knob location
	4- While holding the lever, put the knob back 5- Let the lever go

NOTE

We feel that it might not be necessary to decouple the CCD camera if the instrument is handled carefully. However, we strongly recommend doing it if the instrument has to be handled by untrained personnel (shipping by truck for example).

10.2 Connect I/O peripherals

Connect a monitor, a keyboard and a mouse on the "internal Computer Access" ports as described in Figure 3 page 8.

10.3 Turn system ON

Turn the main power on. The GREEN LED flashes until the operating system has booted and all the controllers are running. This can take up to 2 minutes.

10.4 Start the software applications

Start the "Acton MonoControl" software and :

- Choose the diverter position between SIDE (direct entrance) or FRONT (spectrometer)
- Choose the center wavelength

Use the web browser to display the "Instrument Control" web page. Choose the streak camera mode.

Start the "Image SGL" software and :

- Initialize CCD
- Turn the Peltier cooler on
- Set Exposure Time

Wait until the CCD temperature as reach set point (-10°C).

10.5 Take a Static Image

Use the "Instrument Control" web page to select the operation mode: "Static 10kV" or "Static 15 kV"

It is recommended to first use the the "Static 10 kV" mode until one is certain of the light level. The cathode is less sensitive in this mode.

Then choose the nominal value of the cathode voltage which is 15 kV.

Use the "Instrument Control" web page to:

- Turn Static HV on (yellow button): the YELLOW LED flashes for about 30 seconds and stays on
- Turn Sweep HV on (blue button): the BLUE LED flashes for about 15 seconds and stays on

Use the "Image SGL" software to:

- Take a picture and save it to the hard drive of the Control Unit

Use the "Instrument Control" web page or the hardware interface to turn HV off (yellow button): the YELLOW LED flashes for about 10 seconds and stays off

10.6 Synchronizing the Streak Camera

10.6.1 Connect the triggers

Using a digital oscilloscope, make sure the trigger signals comply with the specification given in section 6.1.3 page 10
Connect the triggers signals (Sweep and ACQ) to the camera.

10.6.2 Take an image in timing mode

Use the "Instrument Control" web page to select the operation mode: **"Timing XXns"** and turn on the Static HV (yellow button) and the Sweep HV on (blue button)

Use the "Image SGL" software to;

- Set exposure time to 0.1s
- Click on the "Arm Camera" button: The CCD status will change to "Waiting for trigger"
- Send the light pulse, the Sweep trigger and the ACQ trigger

A bias voltage is applied such that the sweep starts in the screen. The signal sweeps at the selected speed but the amplitude of the ramps are reduced such that a streaked image is always seen on the screen. In other words, after a shot, if the signal appears:

- at the **base** of the ramp (low on the screen), it means that the trigger arrives too **late**.
- at the **top** of the ramp (high on the screen), it means that the trigger arrives too **early**.
- in the middle of the ramp (centre of screen), it means that the trigger is close to the correct value but too early by a certain Δt (refer to test report). The user can add this Δt and switch to normal sweep mode to get the correct synchronization.

10.7 Taking an image in sweep mode

Set the sweep trigger delay to the right value (refer to the test report).

Use the "Instrument Control" web page to select the operation mode: **"Sweep XXns"** and turn on the Static HV (yellow button) and the Sweep HV on (blue button)

Use the "Image SGL" software to:

- Set exposure time to 0.1s
- Click on the "Acquire Image" button: The CCD status will change to "Waiting for trigger"
- Send the light pulse, the Sweep trigger and the ACQ trigger